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(21) International Application Number: PCT/NL90/00025 (22) International Filing Date: 5 March 1990 (05.03.90) (30) Priority data: 319,126 6 March 1989 (06.03.89) US (71) Applicant: SPECTRUM SCIENCES B.V. [NL/NL]; Zijdweg 6, NL-2244 BG Wassenaar (NL). (72) Inventors: LANDA, Benzion ; 10010-119 Street, Edmon- ton, Alberta T5J 0J0 (CA). ALMOG, Yaacov ; 2 Hecha- lutz Street, 76 100 Rehovot (IL). PELED, Amnon ; 12 Jean Juares Street, 76 100 Rehovot (IL). (74) Agents: DE BRUIJN, Leendert, C. et al.; Nederlandsch Octrooibureau, Scheveningsweg 82, P.O. Box 29720, NL-2502 LS The Hague (NL).		(81) Designated States: AT (European patent), BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent). Published <i>With international search report.</i> <i>With amended claims.</i>

(54) Title: LIQUID DEVELOPER SYSTEMS WITH SELF-REPLENISHMENT OF BULK CONDUCTIVITY

(57) Abstract

A self-replenishing liquid developer system for an electrostatic imaging system including an insulating non-polar carrier liquid, toner particles dispersed in the carrier liquid, at least one charge director compound having a limited solubility in the carrier liquid and dissolved therein at its saturation concentration and excess of the at least one charge director compound comprised in a solid phase and being in equilibrium contact with the carrier liquid.

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1 LIQUID DEVELOPER SYSTEMS WITH SELF-REPLENISHMENT
2 OF BULK CONDUCTIVITY

3 FIELD OF THE INVENTION

4 This invention relates to the field of
5 electrostatic imaging, and more particularly to a liquid
6 developer system having improved properties.

7 BACKGROUND OF THE INVENTION

8 In the art of electrostatic photocopying or photo
9 printing, a latent electrostatic image is generally produced
10 by first providing a photoconductive imaging surface with a
11 uniform electrostatic charge, e.g. by exposing the imaging
12 surface to a charge corona. The uniform electrostatic
13 charge is then selectively discharged by exposing it to a
14 modulated beam of light corresponding, e.g., to an optical
15 image of an original to be copied, thereby forming an
16 electrostatic charge pattern on the photoconductive imaging
17 surface, i.e. a latent electrostatic image. Depending on
18 the nature of the photoconductive surface, the latent image
19 may have either a positive charge (e.g. on a selenium
20 photoconductor) or a negative charge (e.g. on a cadmium
21 sulfide photoconductor). The latent electrostatic image can
22 then be developed by applying to it oppositely charged
23 pigmented toner particles, which adhere to the undischarged
24 "print" portions of the photoconductive surface to form a
25 toner image which is subsequently transferred by various
26 techniques to a copy sheet (e.g. paper).

27 In liquid-developed electrostatic imaging, the toner
28 particles are generally dispersed in an insulating non-polar
29 liquid carrier, generally an aliphatic hydrocarbon fraction,
30 which generally has a high-volume resistivity above 10^9 ohm
31 cm, a dielectric constant below 3.0 and a low vapor pressure
32 (less than 10 torr. at 25°C). The liquid developer system
33 further comprises so-called charge directors, i.e. compounds
34 capable of imparting to the toner particles an electrical
35 charge of the desired polarity and uniform magnitude so that
36 the particles may be electrophoretically deposited on the
37 photoconductive surface to form a toner image. These charge
38 director compounds are generally ionic or zwitterionic

1 compounds which are soluble in the non polar carrier liquid.
2 This desired charging is achieved by providing a constant
3 optimum concentration of charge director compound in the
4 carrier liquid, which concentration is usually determined so
5 as to achieve the highest copy quality for the particular
6 application.

7 Stable electrical characteristics of the liquid
8 developer, in particular its bulk conductivity, are crucial
9 to achieve high quality imaging, particularly when a large
10 number of impressions are to be produced without changing
11 the liquid developer system. A major factor determining the
12 electrical characteristics of the liquid developer and
13 affecting the electrophoretic developing process of the
14 toner particles, is the concentration of the charge director
15 in the carrier liquid. Thus, one of the major problems
16 arising in liquid-developed electrostatic imaging is the
17 variation in the charge director concentration and it is
18 believed that many low quality copies are a result of charge
19 director imbalance in the liquid developer system.

20 The application of liquid developer to the
21 photoconductive surface clearly depletes the overall amount
22 of liquid developer in the reservoir of an electrocopying or
23 electropainting machine of this type. In practice, the
24 liquid reservoir is continuously replenished, as necessary,
25 by addition of two liquids from two separate sources, the
26 one providing carrier liquid and the other - a concentrated
27 dispersion of toner particles in the carrier liquid. This
28 is necessary in order to maintain in the carrier liquid in
29 the reservoir a relatively constant concentration of toner
30 particles, because the total amounts of carrier liquid and
31 toner particles utilised per electrocopy vary as a function
32 of the proportional area of the printed portions of the
33 latent image on the photoconductive surface. An original
34 having a large proportion of printed area will cause a
35 greater depletion of toner particles in the liquid developer
36 reservoir, as compared to an original with a small
37 proportion of printed area. Thus, in accordance with the
38 aforementioned practice, the rate of replenishment of

1 carrier liquid is controlled by monitoring the overall
2 amount or level of liquid developer in the reservoir,
3 whereas the rate of replenishment of toner particles (in the
4 form of a concentrated dispersion in carrier liquid) is
5 controlled by monitoring the concentration of toner
6 particles in the liquid developer in the reservoir. An
7 optical float can combine both these functions, i.e. can be
8 utilized to monitor both the overall amount of liquid
9 developer in the reservoir and the toner particle
10 concentration therein.

11 The amount of charge director in the liquid developer
12 reservoir must also be replenished, since the charge
13 director is also depleted together with the carrier liquid
14 and the toner particles. In existing liquid-developed
15 electrostatic imaging machines the charge director is
16 replenished by adding it with the carrier liquid
17 replenishment or with the concentrated toner dispersion. As
18 explained hereinbelow, this results in charge director
19 imbalance in the liquid developer system with consequent
20 impairment of the quality of the copies.

21 As discussed above, the amount of toner particles
22 utilized per electrocopy varies in proportion to the
23 relative printed area of the image. Thus, a large number of
24 so-called "white" copies (i.e. originals with small printed
25 areas) will result in very small depletion of toner
26 particles whereas the amount of carrier liquid depleted will
27 be comparatively large. This amount of carrier liquid will
28 be replenished and, in machines designed for adding the
29 charge director only with the replenished carrier liquid,
30 this will result in an increase of the concentration of
31 charge director relative to the toner concentration. It can
32 easily be seen that an opposite result will be observed in a
33 photocopier machine designed so that the charge director is
34 replenished together with the concentrated toner suspension
35 only. In such machines a large number of "white" copies
36 will cause a decrease in the concentration of charge
37 director in the liquid developer system.

38 Similarly, a large number of "black" copies (i.e.

1 originals with large printed areas) will cause a degradation
2 of copy quality in opposite directions to the above. In
3 machines wherein charge director is added with the carrier
4 liquid only, a large number of black copies will reduce the
5 concentration of charge director in the liquid developer,
6 resulting in degraded copies. Against this, in machines
7 where charge director is added to the reservoir with the
8 concentrated toner suspension only, its concentration in the
9 liquid developer will be increased by a larger number of
10 black copies, resulting in lighter than optimal copies.

11 A possible solution to the above problem of charge
12 director imbalance in the liquid developer would be to
13 monitor separately the concentration of the charge director
14 and replenish it separately from a separate source. This
15 solution, however, is uneconomic, because it would involve
16 the cost and complexity of providing additional measurement
17 devices and replenishment mechanism. It follows that a
18 simpler and more feasible solution to the problem is needed.

19 It is an object of the present invention to provide a
20 solution to the problem of charge director imbalance in
21 liquid developer systems, thereby to maintain a constant
22 high-quality of copies in electrostatic imaging processes,
23 independent of the "print" proportions of the originals.

24 Other objects and advantages of the present invention
25 will become clear from the following description of the
26 invention.

27 SUMMARY OF THE INVENTION

28 The above object is achieved by the present invention
29 which, in accordance with one aspect thereof, provides a
30 self-replenishing liquid developer system for use in
31 electrostatic imaging, which system comprises:

- 32 (a) an insulating non-polar carrier liquid;
- 33 (b) toner particles dispersed in said carrier liquid;
- 34 (c) at least one charge director compound having a
35 limited solubility in said carrier liquid and dissolved
36 therein at its saturation concentration; and
- 37 (c) excess of said at least one charge director
38 compound comprised in a solid phase and being in equilibrium

1 contact with said carrier liquid.

2 The present invention is based on the concept of using
3 a charge director compound which has a limited low
4 solubility in the carrier liquid, such that the saturation
5 concentration of the charge director in the carrier liquid
6 is at a proper concentration as to bring about the
7 electrical charging of the toner particles, to disperse them
8 and to maintain them at the desired degree of dispersion.
9 When such a saturated solution of charge director in the
10 carrier liquid is maintained in contact with a solid phase
11 comprising or consisting of a considerable excess of the
12 charge director compound, this solid phase will serve as a
13 reservoir for the charge director compound. Whenever the
14 concentration of this charge director in the liquid phase,
15 i.e. in the carrier liquid in contact with the solid phase,
16 falls below its saturation concentration value, it will be
17 rapidly equilibrated with the excess charge director in the
18 solid phase so that the saturation concentration of the
19 charge director in the carrier liquid is constantly and
20 automatically maintained. As shown in the following, non-
21 limiting examples, suitable charge director-carrier liquid-
22 toner systems can be found which have the desired
23 characteristics.

24 In accordance with one embodiment of the present
25 invention, it is the toner particles themselves which serve
26 as the solid phase comprising the excess charge director
27 compound. To this end, from about 5 to about 10% by weight
28 of charge director compound, based on the total weight of
29 the imaging material, are milled together with the remaining
30 ingredients of the imaging material to form the toner
31 particles.

32 In accordance with this embodiment the concentration of
33 the charge director compound is continuously maintained by
34 natural and rapid equilibration between the charge director
35 in solution in the carrier liquid and the excess charge
36 director comprised in the toner particles. When, for
37 example, a large number of white copies are made, resulting
38 in a replenishment of pure carrier liquid thereby lowering

1 the concentration of charge director in the liquid developer,
2 some charge director compound will diffuse from the solid
3 phase, i.e. from within the toner particles, into the
4 carrier liquid until dynamic equilibrium is reached when the
5 concentration of charge director in the carrier liquid
6 reaches its saturation value. In the opposite case, where a
7 large number of "black" copies are made, consuming a
8 relatively high proportion of toner particles as compared to
9 the consumed carrier liquid, the resultant replenishment of
10 concentrated suspension of toner particles in carrier liquid
11 into the reservoir, would not affect the concentration of
12 charge director because the added carrier liquid in said
13 concentrated suspension will already be saturated with the
14 charge director compound owing to the presence of excess of
15 that compound in the toner particles in that concentrated
16 suspension.

17 In accordance with an alternative embodiment of the
18 present invention, the excess of charge director compound,
19 preferably in the form of a finely dispersed powder, is
20 contained in a container, at least a portion of the walls of
21 which being made of a porous material which is permeable to
22 the carrier liquid but does not permit the passage
23 therethrough of the particulate solid charge director
24 compound. Such container will be wholly or partially
25 immersed in the reservoir of liquid developer so as to be in
26 direct contact therewith. A suitable container may be, for
27 example a closed bag made of thin porous sheet material,
28 e.g. filter paper or the like. In this embodiment of the
29 invention, the liquid developer is always in direct
30 equilibrium contact with the excess charge director in solid
31 form, thereby achieving a constant saturation concentration
32 of charge director in the liquid developer.

33 The invention will be further described by the follow-
34 ing, non-limiting examples, all of which relate to negative-
35 working liquid developer systems, i.e. those in which the
36 toner particles are negatively charged. It should be
37 understood, however, that the invention is not limited to
38 such negative-working liquid developers, but is rather

1 equally applicable to positive-working liquid developer
2 systems. It should also be understood that the invention is
3 not limited to the specific toner of Preparation 1 herein
4 nor to the specific carrier liquids exemplified, but rather
5 extends to all modifications falling within the scope of the
6 claims.

7 PREPARATION I

8 Preparation of Black Imaging material

9 Black imaging material which is used in Examples 1 to 5
10 hereinbelow is prepared as follows:

11 10 parts by weight of Elvax 5720 (E.I. Du Pont), and 5
12 parts by weight of Isopar L (Exxon) are mixed at low speed
13 in a jacketed double planetary mixer connected to an oil
14 heating unit, for 1 hour, the heating unit being set at
15 130°C.

16 A mixture of 2.5 parts by weight of Mogul L carbon
17 black (Cabot) and 5 parts by weight of Isopar L is then
18 added to the mix in the double planetary mixer and the
19 resultant mixture is further mixed for 1 hour at high speed.
20 20 parts by weight of Isopar L preheated to 110°C are added
21 to the mixer and mixing is continued at high speed for 1
22 hour.

23 The heating unit is then disconnected and mixing is
24 continued until the temperature of the mixture drops to
25 40°C.

26 EXAMPLE 1

27 Calcium laurylbenzenesulfonate in toner particles

28 Calcium laurylbenzenesulfonate was prepared from its
29 68 - 70% solution in xylol and isobutanol commercially
30 available under the name Emcol P-1020 (Witco), by one of the
31 following methods:

32 1) Emcol P-1020 is subjected to vacuum distillation
33 at 170°C. The solid residue is allowed to equilibrate with
34 air moisture and dissolved in Isopar H at the desired
35 concentration.

36 2) The Emcol P-1020 is diluted with Isopar H to a 10%
37 content of non volatile solids (n.v.s.) and the obtained
38 solution is allowed to stand at room temperature whereupon a

1 yellow sediment is formed followed within 30-35 days by
2 precipitation of a white material which is separated and
3 dissolved in Isopar H at the desired concentration.

4 The crude material thus obtained is washed repeatedly
5 with Isopar H with stirring until a constant conductance in
6 the supernatant Isopar H solution is reached. The resultant
7 solid residue was dried.

8 The solubility of calcium laurylbenzenesulfonate in
9 Isopar H was determined by U.V. spectrophotometry and found
10 to be 0.069% by weight.

11 Preparation of the liquid developer.

12 One part by weight of the solid dry calcium lauryl
13 benzenesulfonate was co-melted with 9 parts by weight of
14 black imaging material at 130°C. The melt was cooled and
15 100 g thereof and 120 g of Isopar L were milled together for
16 19 hours in an attritor to obtain a dispersion of particles
17 with an average diameter of about 2 μ . The attrited material
18 obtained was washed several times with Isopar H and then
19 dispersed in Isopar H at a content of 1% n.v.s. The
20 conductance of the toner was 3 pmho/cm.

21 The performance of the developer was tested in a Savin
22 V-35 photocopier machine using both Savin 2200+ and Printers
23 Stock copy sheets. The results obtained are summarised in
24 the following Table 1.

25 TABLE 1

27 Substrate	28 Solid 29 Area Density (SAD)	30 Fixing	31 Bleed 32 through (SAD)
33 Savin 2200 +	34 1.51	35 good	36 0.15
37 Printers			
38 Stock	1.67	good	0.09

36 EXAMPLE 2

37 Sodium laurylbenzenesulfonate in toner

38 The title material was purchased from Fluka and used

1 without further treatment, after being left to equilibrate
2 with air moisture. The material was repeatedly washed with
3 Isopar H until a constant conductance of the supernatant
4 solution was reached.

5 The solubility of sodium laurylbenzenesulfonate in
6 Isopar H was determined spectrophotometrically to be 0.027%
7 by weight.

8 Preparation of the liquid developer

9 One part of weight of sodium laurylbenzenesulfonate was
10 co-melted with 9 parts by weight of black imaging material.
11 100 g of the co-melt were mixed with 120 g of Isopar G and
12 attrited as described in Example 1 to give an average
13 particle size of about 1.9μ . The final developer, after
14 washing, had a conductance of 5.5 pmho/cm at a concentration
15 of 1% n.v.s. in Isopar G. It was placed in the developer
16 bath of a Savin 870 photocopier and the performance on
17 various substrates was tested. The results are shown in the
18 following Table 2.

19 TABLE 2

21 Substrate	22 S.A.D.	23 Transfer efficiency %
24 Gilbert Bond	1.33	72
25 Printers Stock	1.64	87

27 EXAMPLE 3

28 Sodium diamyl sulfosuccinate in toner

29 The title material is commercially available under the
30 name Aerosol AY (Cyanamide). It was used without further
31 treatment, except for equilibration with the air humidity
32 and successive washing with Isopar H to constant conductance
33 (about 1-2 pmho/cm).

34 Preparation of the developer

35 5 parts of sodium diamyl sulfosuccinate and one part of
36 aluminium stearate were co-melted with 44 parts by weight of
37 black imaging material in accordance with the procedure
38 described in Example 1. 100 g of the co-melt were added to

1 120 g of Isopar H and milled for 19 hours as described in
2 Example 1. The milled toner thus obtained was washed several
3 times with Isopar and diluted with Isopar G to a 1% n.v.s.
4 content of toner.

5 The obtained dispersion was placed in the developer
6 bath of a Savin 870 photocopier and the performance tested
7 on various substrates. The results are summarised in the
8 following Table 3.

9 TABLE 3

11 Substrate	12 S.A.D.	13 Transfer Efficiency (%)
14 Savin 2200 +	1.32	84
15 Gilbert Bond	1.61	63

17 EXAMPLE 4

18 Calcium laurylbenzenesulfonate in filter paper bag.

19 The material obtained as described in Example 1 was
20 placed in a bag prepared from folded Whatman MN filter
21 paper, and the bag was immersed in a liquid developer and
22 the conductance of the liquid developer measured. From time
23 to time the bag was removed from the liquid developer which
24 was centrifuged to remove the supernatant and the resultant
25 toner particles were redispersed in pure Isopar H. There-
26 after, the filter paper bag containing the charge director
27 compound was re-installed and after several hours of stir-
28 ring the conductivity of the liquid developer was measured
29 again. To eliminate effects related to possible permeation
30 of the charged toner particles through the filter paper, the
31 conductance values obtained were compared with those of an
32 identical control bag immersed in pure Isopar H.

33 It was found that the conductance of the liquid
34 developer surrounding the bag reached a time-independent
35 steady-state value of about 4 pmho/cm at a toner concentra-
36 tion of 1% n.v.s. The same conductance value was observed
37 when the bag was removed from the toner suspension and
38 immersed in pure isopar H.

1 Measurements in a test plating cell showed negative
2 plating with the above described liquid developer system.

3 EXAMPLE 5

4 When the procedure of Example 4 was repeated with
5 sodium laurylbenzenesulfonate (in Isopar H), calcium di-
6 isobutyl sulfosuccinate (in Isopar G) and sodium diamyl
7 sulfosuccinate (in Isopar H using a bag made from Whatman
8 No. 2 filter paper), similar results as in Example 4 were
9 obtained.

10 In all the above cases, a steady-state conductance was
11 reached and significant charge transport followed by
12 negative plating were observed in the test cell. In the
13 case of calcium diisobutyl sulfosuccinate a markedly low
14 conductance of 0.5-2 pmho/cm was measured (at toner con-
15 centration of 1% n.v.s.), but this did not affect the pro-
16 nounced charge transport and the negative plating in the
17 cell.

1 What is claimed:

2 1. A self-replenishing liquid developer system for an
3 electrostatic imaging system comprising:

4 (a) an insulating non-polar carrier liquid;

5 (b) toner particles dispersed in said carrier liquid;

6 (c) at least one charge director compound having a
7 limited solubility in said carrier liquid and dissolved
8 therein at its saturation concentration; and

9 (d) excess of said at least one charge director
10 compound comprised in a solid phase and being in equilibrium
11 contact with said carrier liquid.

12
13 2. A liquid developer system according to claim 1 wherein
14 said excess of charge director compound is comprised in said
15 toner particles.

16
17 3. A liquid developer system according to claim 1 wherein
18 said excess of charge director compound is in a finely
19 dispersed solid form and is comprised in a container in
20 contact with and permeable to said carrier liquid throughout
21 at least a portion of the walls of the container.

22
23 4. A liquid developer system according to claim 3, wherein
24 said container is a bag made of thin sheets of a porous
25 material.

26
27 5. A liquid developer system according to claim 4, wherein
28 said porous material is filter paper.

29
30 6. A liquid developer system according to claim 1, wherein
31 said carrier liquid is a branched chain aliphatic
32 hydrocarbon or a mixture of such hydrocarbons.

33
34 7. A liquid developer system according to claim 1 wherein
35 said carrier liquid is an isoparaffinic hydrocarbon fraction
36 having a boiling range above 155°C.

37
38 8. A liquid developer system according to claim 1, wherein

1 said charge director compound is ionic or zwitterionic.

2

3 9. A liquid developer system according to claim 8, wherein
4 said charge director compound is a metal soap.

5

6 10. A liquid developer system according to claim 1, wherein
7 said charge director compound is capable of imparting a
8 negative charge to the toner particles suspended in the
9 carrier liquid.

10

11 11. A liquid developer system according to claim 9, wherein
12 said charge director compound is calcium lauryl-
13 benzenesulfonate.

14 12. A liquid developer system according to claim 9, wherein
15 said charge director compound is sodium lauryl-
16 benzenesulfonate.

17

18 13. A liquid developer system according to claim 9,
19 wherein said charge director compound is sodium diamyl
20 sulfosuccinate.

21

22 14. An electrostatic imaging process comprising the steps
23 of:

24 (a) forming a latent electrostatic image on a
25 surface;

26 (b) applying to said surface electrically charged
27 toner particles from a liquid developer system according to
28 claim 1, thereby to form a toner image on said surface; and

29 (c) transferring the resulting toner image to a
30 substrate.

31

32 15. An electrostatic imaging process comprising the
33 steps of:

34 (a) electrostatically charging a photoconductive
35 surface;

36 (b) exposing said photoconductive surface to an optical
37 image thereby forming a latent electro static image on said
38 photoconductive surface;

1 (c) applying to said photoconductive surface electri
2 cally charged toner particles from a liquid developer system
3 according to claim 1, thereby to form a toner image on said
4 photoconductive surface; and

5 (d) transferring the resulting toner image to a copy
6 sheet substrate.

7

8 16. A method for developing a latent electrostatic
9 image in a liquid-developed electrostatic imaging process,
10 which comprises the use of a liquid developer system
11 according to claim 1.

12

13 17. A liquid-developed electrocopying or electro-
14 printing apparatus comprising a self replenishing liquid
15 developing system according to claim 1.

2 1. A self-replenishing liquid developer system for an
3 electrostatic imaging system comprising:
4 (a) an insulating non-polar carrier liquid;
5 (b) toner particles dispersed in said carrier liquid;
6 (c) at least one charge director compound having a
7 limited solubility in said carrier liquid and dissolved
8 therein at its saturation concentration; and
9 (d) excess of said at least one charge director
10 compound comprised in a solid phase and being in equilibrium
11 contact with said carrier liquid.

12
13 2. A liquid developer system according to claim 1 wherein
14 said excess of charge director compound is comprised in said
15 toner particles.

16
17 3. A liquid developer system according to claim 1 wherein
18 said excess of charge director compound is in a finely
19 dispersed solid form and is comprised in a container in
20 contact with and permeable to said carrier liquid throughout
21 at least a portion of the walls of the container.

22
23 4. A liquid developer system according to claim 3, wherein
24 said container is a bag made of thin sheets of a porous
25 material.

26
27 5. A liquid developer system according to claim 4, wherein
28 said porous material is filter paper.

29
30 6. A liquid developer system according to any of the
31 preceding claims wherein said carrier liquid is a branched
32 chain aliphatic hydrocarbon or a mixture of such
33 hydrocarbons.

34
35 7. A liquid developer system according to any of the
36 preceding claims wherein said carrier liquid is an
37 isoparaffinic hydrocarbon fraction having a boiling range
38 above 155°C.

1

2 8. A liquid developer system according to any of the
3 preceding claims wherein said charge director compound is
4 ionic or zwitterionic.

5

6 9. A liquid developer system according to claim 8, wherein
7 said charge director compound is a metal soap.

8

9 10. A liquid developer system according to any of the
10 preceding claims wherein said charge director compound is
11 capable of imparting a negative charge to the toner
12 particles suspended in the carrier liquid.

13

14 11. A liquid developer system according to any of the
15 preceding claims wherein said charge director compound is
16 calcium laurylbenzenesulfonate.

17

18 12. A liquid developer system according to any of the
19 preceding claims wherein said charge director compound is
20 sodium laurylbenzenesulfonate.

21

22 13. A liquid developer system according to any of the
23 preceding claims wherein said charge director compound is
24 sodium diethyl sulfosuccinate.

25

26 14. An electrostatic imaging process comprising the steps
27 of:

28 (a) forming a latent electrostatic image on a
29 surface;

30 (b) applying to said surface electrically charged
31 toner particles from a liquid developer system according to
32 any of the preceding claims to form a toner image on said
33 surface; and

34 (c) transferring the resulting toner image to a
35 substrate.

36

37 15. An electrostatic imaging process comprising the
38 steps of:

1 (a) electrostatically charging a photoconductive
2 surface;

3 (b) exposing said photoconductive surface to an optical
4 image thereby forming a latent electro static image on said
5 photoconductive surface;

6 (c) applying to said photoconductive surface electri-
7 cally charged toner particles from a liquid developer
8 system according to any of claims 1-13 to form a toner image
9 on said photoconductive surface; and

10 (d) transferring the resulting toner image to a copy
11 sheet substrate.

12

13 16. A method for developing a latent electrostatic
14 image in a liquid-developed electrostatic imaging process,
15 which comprises the use of a liquid developer system
16 according to any of claims 1-13.

17

18 17. A liquid-developed electrocopying or electro-
19 printing apparatus comprising a self replenishing liquid
20 developing system according to any of claims 1-13.

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁵ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: G 03 G 9/12, 13/10														
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 20%; border: 1px solid black; padding: 2px;">Classification System</th> <th style="border: 1px solid black; padding: 2px;">Classification Symbols</th> </tr> <tr> <td style="border: 1px solid black; padding: 5px; height: 40px; vertical-align: top;">IPC5</td> <td style="border: 1px solid black; padding: 5px; vertical-align: top;">G 03 G</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸</div>			Classification System	Classification Symbols	IPC5	G 03 G								
Classification System	Classification Symbols													
IPC5	G 03 G													
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border: 1px solid black; padding: 2px;">Category *</th> <th style="border: 1px solid black; padding: 2px;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="border: 1px solid black; padding: 2px;">Relevant to Claim No.¹³</th> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="border: 1px solid black; padding: 5px;"> WO, A1, 8705128 (SAVIN CORPORATION) 27 August 1987, see page 2, line 16 - line 19; page 2, line 26 - line 27; claims 1,8 <div style="text-align: center; margin-top: 10px;">--</div> </td> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">14-17</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="border: 1px solid black; padding: 5px;"> EP, A2, 0247369 (E.I. DU PONT DE NEMOURS AND COMPANY) 2 December 1987, see claim 1 <div style="text-align: center; margin-top: 10px;">--</div> </td> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">1-17</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="border: 1px solid black; padding: 5px;"> GB, A, 2194644 (RICOH COMPANY LTD) 9 March 1988, see figures 17-20; claims 1,26 <div style="text-align: center; margin-top: 10px;">--</div> </td> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">1-17</td> </tr> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	WO, A1, 8705128 (SAVIN CORPORATION) 27 August 1987, see page 2, line 16 - line 19; page 2, line 26 - line 27; claims 1,8 <div style="text-align: center; margin-top: 10px;">--</div>	14-17	A	EP, A2, 0247369 (E.I. DU PONT DE NEMOURS AND COMPANY) 2 December 1987, see claim 1 <div style="text-align: center; margin-top: 10px;">--</div>	1-17	A	GB, A, 2194644 (RICOH COMPANY LTD) 9 March 1988, see figures 17-20; claims 1,26 <div style="text-align: center; margin-top: 10px;">--</div>	1-17
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<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; vertical-align: top; padding: 2px;"> ¹⁰ * Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed </td> <td style="width: 50%; vertical-align: top; padding: 2px;"> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family </td> </tr> </table>			¹⁰ * Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family										
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IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of the Actual Completion of the International Search <div style="text-align: center; font-weight: bold; margin-top: 5px;">7th June 1990</div> </td> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of Mailing of this International Search Report <div style="text-align: center; font-weight: bold; margin-top: 5px;">26.06.90</div> </td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;"> International Searching Authority <div style="text-align: center; font-weight: bold; margin-top: 10px;">EUROPEAN PATENT OFFICE</div> </td> <td style="border: 1px solid black; padding: 5px;"> Signature of Authorized Officer <div style="text-align: center; margin-top: 10px;">F.W. HECK </div> </td> </tr> </table>			Date of the Actual Completion of the International Search <div style="text-align: center; font-weight: bold; margin-top: 5px;">7th June 1990</div>	Date of Mailing of this International Search Report <div style="text-align: center; font-weight: bold; margin-top: 5px;">26.06.90</div>	International Searching Authority <div style="text-align: center; font-weight: bold; margin-top: 10px;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer <div style="text-align: center; margin-top: 10px;">F.W. HECK </div>								
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 3669886 (GEORGE E. KOSEL) 13 June 1972, see column 7, line 27 - line 38; abstract	1-13
A	US, A, 4003500 (EBERHARD SCHÖRNIG) 18 January 1977, see abstract; claim 1	1-5
A	US, A, 4193683 (FRED R. LANGNER) 18 March 1980, see abstract; figure 5	1-5
A	US, A, 4656966 (ROBERT A. GUISTINA) 14 April 1987, see column 3, line 1 - line 13; figure 1	1-13
A	US, A, 4785327 (BENZION LANDA ET AL) 15 November 1988, see column 3, line 40 - line 48; abstract	1-5
P,A	US, A, 4812382 (DOUGLAS E. BUGNER ET AL) 14 March 1989, see table II	11-12
P,A	US, A, 4869991 (JOSEPH DEGRAFT-JOHNSON ET AL) 26 September 1989, see claims 1,2	13

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
 The members are as contained in the European Patent Office EDP file on 07/05/90
 The European Patent office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		EP-A- 0259448	16/03/88
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		AU-B- 473228	17/06/76
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US-A- 4812382	14/03/89	NONE	
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		WO-A- 89/09432	05/10/89

For more details about this annex : see Official Journal of the European patent Office, No. 12/82